Reducing Dependence on Feed Grains for Biofuels

**Technology That Fuels**

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DuPont Biofuels Steering Team

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DuPont & Pioneer Technology Focus

- $1.4 billion in R&D
- Leveraging diverse science for biofuels
- Pioneer: $100MM new investment, 400 scientists

2015 Sustainability Goals

- Double our investment in R&D programs with direct, quantifiable environmental benefits
- Grow annual revenues by $2 billion from products that create energy efficiency and/or significant greenhouse gas emissions reductions (40MM tons of CO2 equivalent)
- Reduce our greenhouse gas emissions at least 15% from a base year of 2004

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Biofuels and the Acre Productivity Challenge

- 1 acre of corn (160 bu) = 439 gallons
- 1 acre of corn stover (50% removal) = 140 gallons of ethanol
- 1 acre of sugar beets (23 tons) = 552 gallons of ethanol
- 1 acre of sugar cane = 600 gallons of ethanol
- 1 acre of soybeans (43 bu) = 60 gallons of biodiesel
- 1 acre of canola (1557#) = 77 gallons of biodiesel

Grasses / Stover Per Acre:

- Assumption: 75 Gallons of ethanol / Ton of dry matter
- Corn Stover: ~48 lb/bu, @ 50% removal = 77 Gallons
- Switch grass: ~5 -10 Ton/A, @ 375 - 750 Gallons
- Miscanthus: ~10 tons / A = 750 – 1000 Gallons

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Traits that maximize grain yield per acre are a key part of the Pioneer biofuels strategy

**Drought Tolerance**

- Numerous early stage leads validated in multiple model crops
- Average annual drought loss $8 billion globally

**Nitrogen Responsiveness**

- Maintain yields using less nitrogen
- Increase yields at current nitrogen levels

**Yield Enhancement**

- Numerous corn leads undergoing inbred evaluation
- Promising leads in soybeans

**Anthracnose Stalk Rot Resistance**

- Estimated U.S. yield loss: $1 billion
- Increases yield, standability, grain quality
- Targeted commercialization in 2008

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Grain Quality is Increasingly Important. Mycotoxins concentrate by a factor of 3X in distillers grain.

Herculex® I – The Better Bt
Because Herculex I has a broader spectrum of insect protection, it can be more effective in helping to prevent kernel damage and the possibility of mycotoxin presence.

Pioneer has a well developed pipeline of traits targeting the ethanol industry...and feed markets

Enabling Technology – Modifying Cell “Software” to produce biomaterials and improved biofuels

DuPont’s technology to modify fermentation microbes is enabling development of improved biofuels - Biobutanol

BioButanol: a 4 carbon alcohol molecule made from corn in existing ethanol facilities
### President Bush Visits DuPont – January 2007

**State of the Union Address**
- “Twenty in Ten” – reduce gasoline usage by 20% in ten years
- 35 B gallons of renewable and alternative fuels by 2017

“I came wondering whether or not cellulosic ethanol was one of those things down the road that may be happening, may not, could end up being science or science fiction. It’s going to be science. It’s working.”

-President George W. Bush, 1/24/07 at DuPont Research Labs

### Ethanol Feedstock Source Scenario

A Scenario for Growth of Bioket to Supply 30% of U.S. Gasoline Demand by 2030

- **Cellulose ethanol**
- **Grain-based ethanol**

### Integrated Corn Biorefinery (ICBR) Technology

Total Technology Package ( lignin separation, saccharification, fermentation)

- $38MM project - 2003
- Multiple collaborations

### Fiber Digestibility Data Shows Large Variation in Hybrids

NDF Digestibility (%)

- 27% variation

### NREL’s View of Biomass Availability

- Crop residues, methane emissions from manure management, methane emissions from landfills and wastewater treatment facilities, forest residues, primary and secondary mill residues, urban wood waste, and dedicated energy crops.

### DuPont / Poet Emmetsburg Project

- $285MM in 6 contracts, combined investment of $1.2B
- Post: $80MM, uses DuPont pre-treatment / fermentation technology to break down complex sugars in stalk material
- Uses corn fiber from the grain, and cobs / husks
- Results: 27% more ethanol per acre, using 83% less energy and 24% less water to operate the plant

- Development of a single pass, dual stream process
- Harvest speed
- Plant portion harvested
- Proximity to processing – economics of longer distances
- Material handling / storage
  - 100 acres, 25 feet deep for a 50MM gallon facility
Corn Has Huge Potential for Biofuels

**Ethanol Productivity**

- **Endosperm**: 435 Gal/Acre
- **Stover**: 18 Gal/Acre (2010)
- **Pericarp**: Gallons / Acre

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**Stover**

- **Grain Starch**: 1,000 gallons / acre by 2020?
- **Grain Fiber**: 486
- **Endosperm**: 435
- **Pericarp**: 18

**Grain Pericarp**

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- **Stover**: 100 Gal/Acre (2010)

**Implications / Issues Summary**

- The science may not be as challenging as the logistics/systems issues
- New market arrangements / relationships between growers and processors
  - More virtual supply chain integration
  - Evolving role of grower participation in the downstream
- New input supplier acre management thought processes, technologies
  - Emergence of more sophisticated ag information systems
  - Biotech targeting new crops
- No guarantees for Midwestern agriculture

Thanks